Graphs, network motifs, and threshold-linear algebra in the brain

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Threshold-linear networks are commonly-used rate models for modeling neural networks in the brain. Although the nonlinearity is quite simple, it leads to rich dynamics that can capture a variety of phenomena observed in neural activity: persistent activity, multistability, sequences, oscillations, etc. Here we study competitive threshold-linear networks, which exhibit both static and dynamic attractors. These networks have corresponding hyperplane arrangements whose oriented matroids encode important features of the dynamics. We will show how the graph associated to such a network yields constraints on the oriented matroid, which in turn constrains the allowed dynamics. As an application, we classify small network motifs and prove that directed cliques of any size have an especially simple fixed point structure.